Atmospheric Composition
AOSC 200

Tim Canty

Class Web Site: http://www.atmos.umd.edu/~tcanty/aosc200

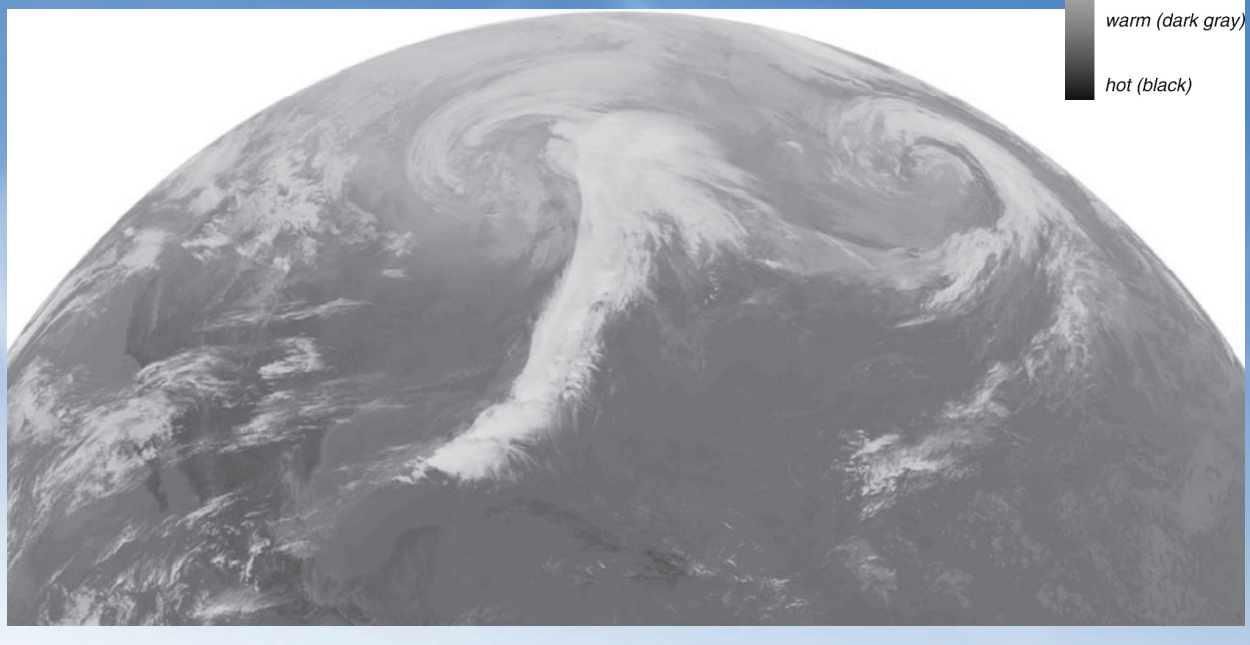
Topics for today:

- Satellite Observations
- Early Atmosphere
- Current Atmosphere
  - Permanent Gases
  - Variable Gases

Lecture 05

Sep 10 2019

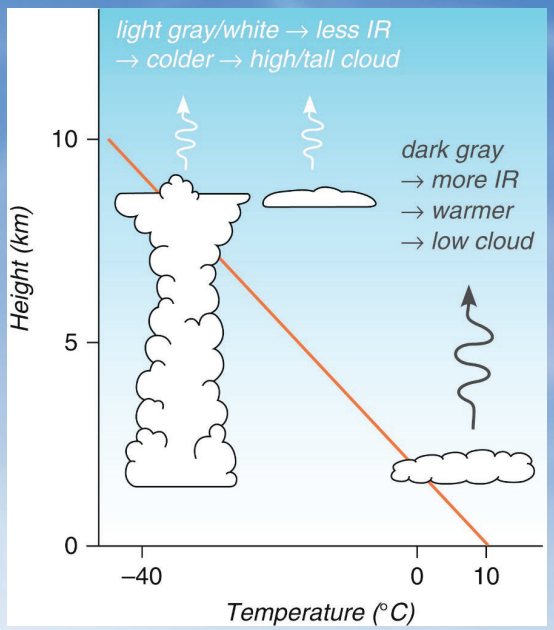
Satellite Imagery: Infrared (heat)



This is a "false color" image. The lighter the color, the colder the temperature. What does this tell us about clouds?

Fig 2-14 *Weather: A Concise Introduction*

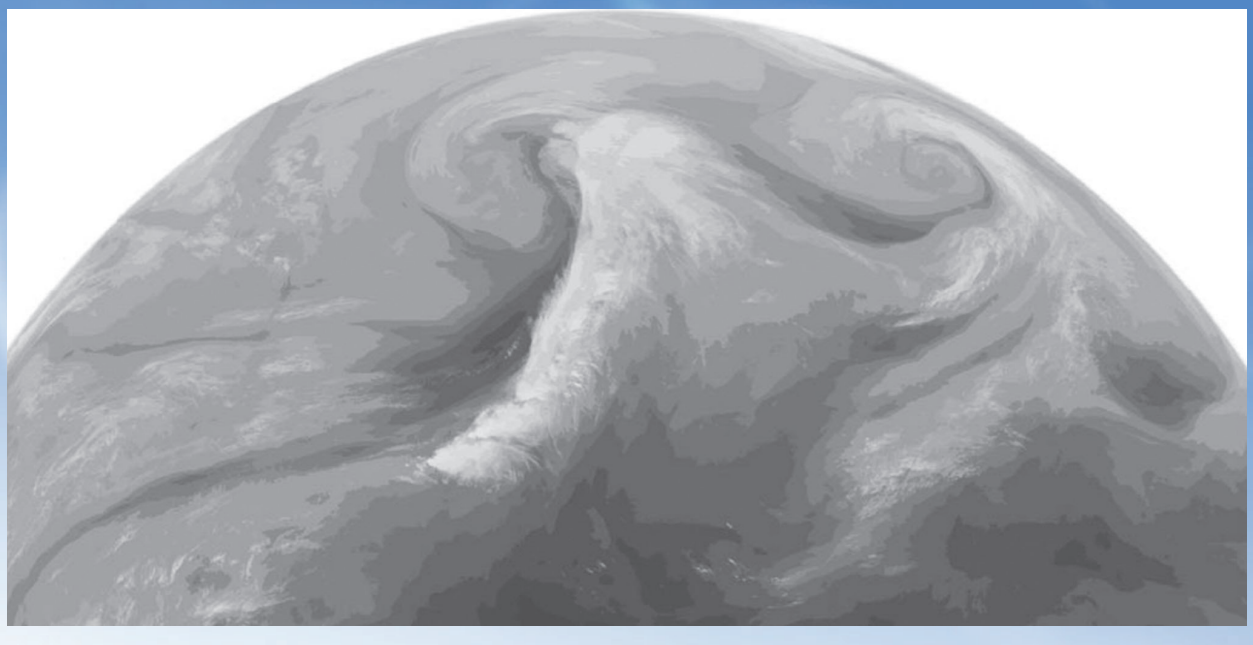
Satellite Imagery: Infrared (heat)



This is a "false color" image. The lighter the color, the colder the temperature.
What does this tell us about clouds?
Can you think of a limitation of the infrared image?

Fig 2-14 *Weather: A Concise Introduction*

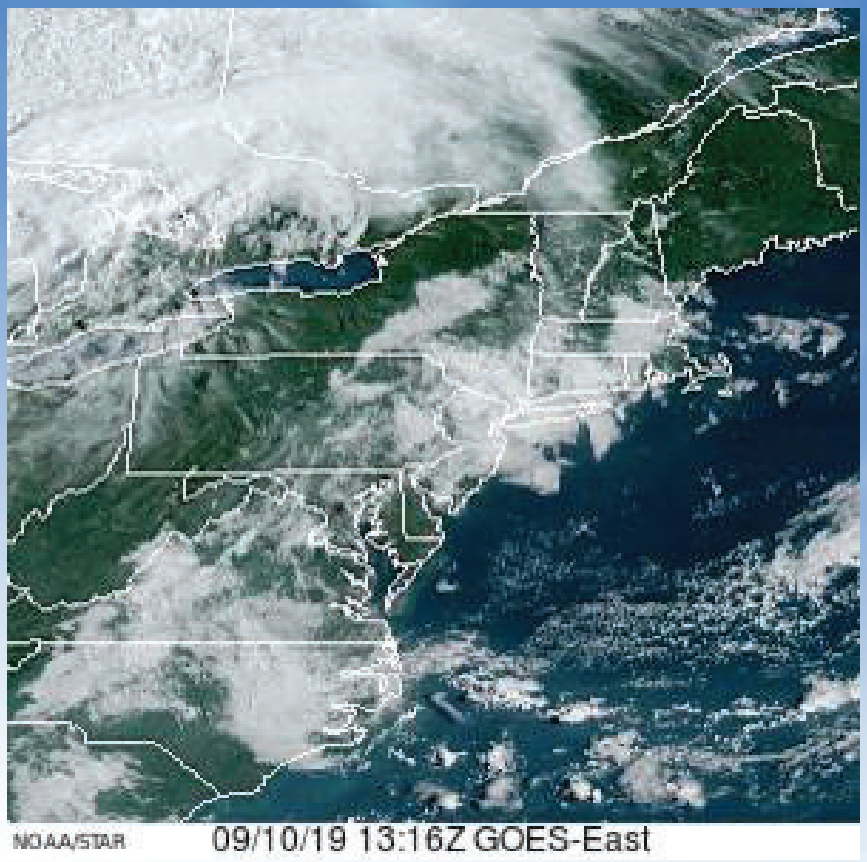
Satellite Imagery: Water Vapor



This is a "false color" image. Water vapor absorbs and emits energy.
You can tune an instrument to only "see" the wavelengths where water vapor absorbs and emits energy

Fig 2-18 *Weather: A Concise Introduction*

Satellites: NOAA GOES16



Atmospheric Composition (What are you breathing?)

TABLE 1.1 Composition of the Atmosphere near the Earth's Surface

PERMANENT GASES			VARIABLE GASES			
Gas	Symbol	Percent (by Volume) Dry Air	Gas (and Particles)	Symbol	Percent (by Volume)	Parts per Million (ppm)
Nitrogen	N_2	78.08	Water vapor	H_2O	0 to 4	
Oxygen	O_2	20.95	Carbon dioxide	CO_2	0.040	400*
Argon	Ar	0.93	Methane	CH_4	0.00018	1.8
Neon	Ne	0.0018	Nitrous oxide	N_2O	0.00003	0.3
Helium	He	0.0005	Ozone	O_3	0.000004	0.04**
Hydrogen	H_2	0.00006	Particles (dust, soot, etc.)		0.000001	0.01–0.15
Xenon	Xe	0.000009	Chlorofluorocarbons (CFCs)		0.00000002	0.0002

*For CO_2, 400 parts per million means that out of every million air molecules, 400 are CO_2 molecules.

**Stratospheric values at altitudes between 11 km and 50 km are about 5 to 12 ppm.

Table 1.1: *Essentials of Meteorology*

Early Earth's Atmosphere

As Earth formed it was very hot. Any water would have evaporated. So, where did the water come from?

Early Earth's Atmosphere

After the oceans formed, CO_2 dissolved into the water, sea creatures used CO_2, water, and sunlight to create carbohydrates. This lead to the creation of …..

Early Earth's Atmosphere

After the oceans formed, CO_2 dissolved into the water, sea creatures used CO_2, water, and sunlight to create carbohydrates. This lead to the creation of ….. Oxygen!!!!

The increase in atmospheric oxygen led to one of the greatest environmental disasters ever!!! The "Oxygen Catastrophy"

Oxygen is toxic to cells (even ours). The build of atmospheric oxygen wiped out anaerobic bacteria ~4 billion years ago.

Endosymbiotic Theory - Lynn Margulis (1967)

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99.96% of the atmosphere "permanent gases"

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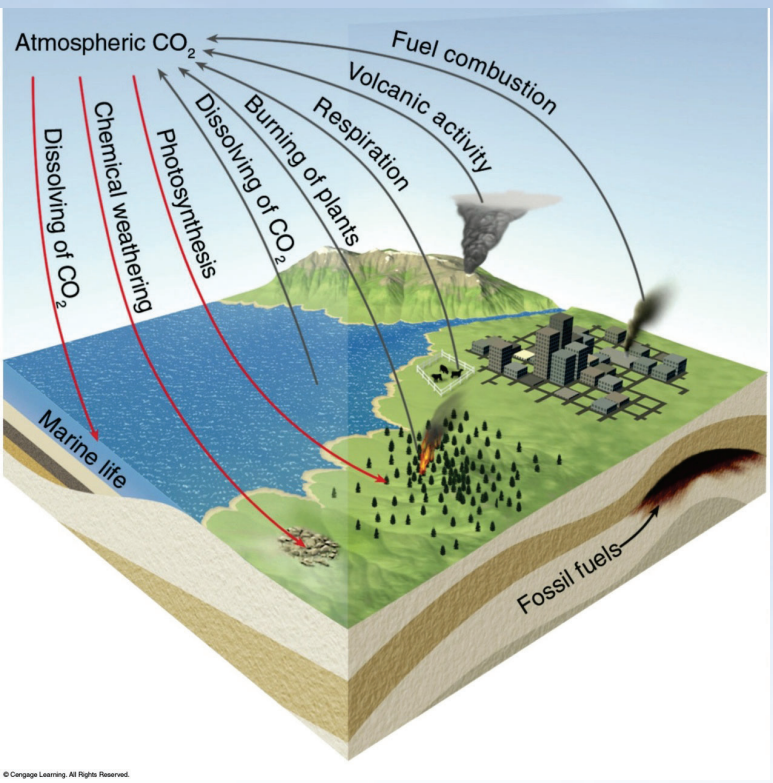
These gases control the chemistry of the atmosphere "variable gases" or "trace gases"

Table 1.1: *Essentials of Meteorology*

Carbon Dioxide (CO_2) Cycle



One of the most talked about Greenhouse Gases.

Some CO_2 is produced naturally

Some CO_2 produced by human activity (anthropogenic)

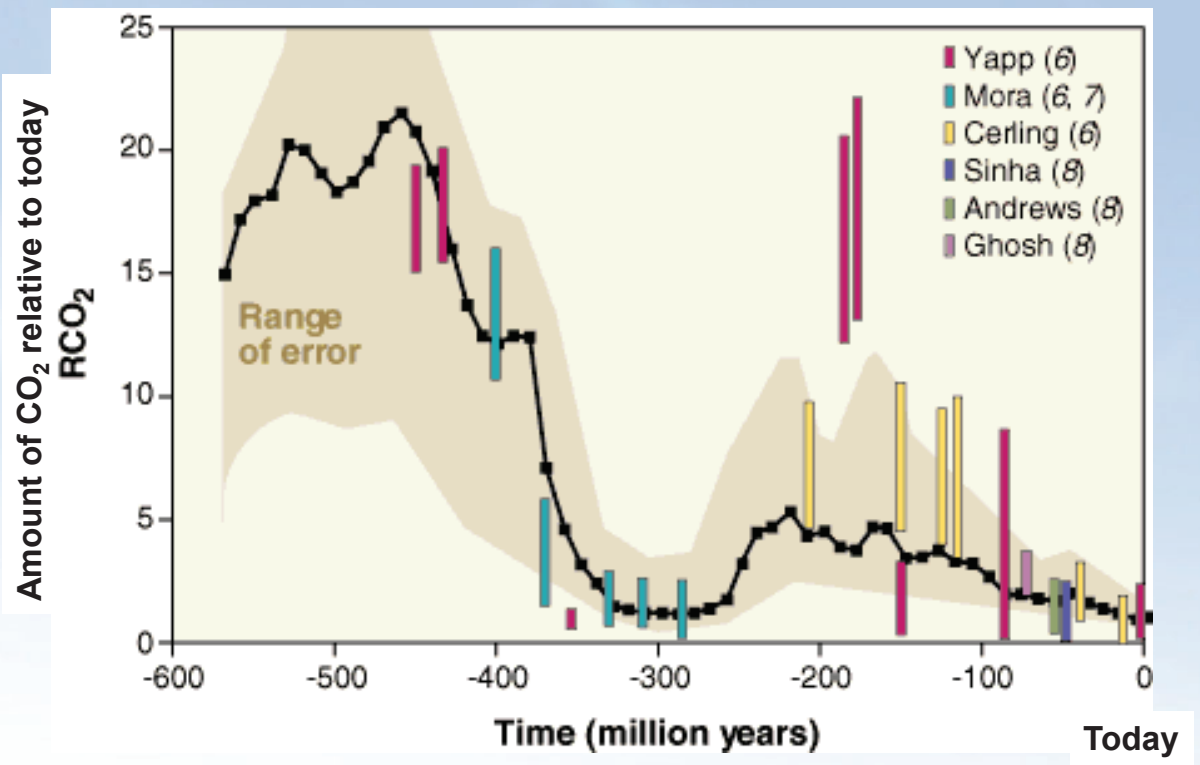
Once in the air, some CO_2:

stays there
goes into ocean
goes into land

CO_2 stays in the air for ~200yrs

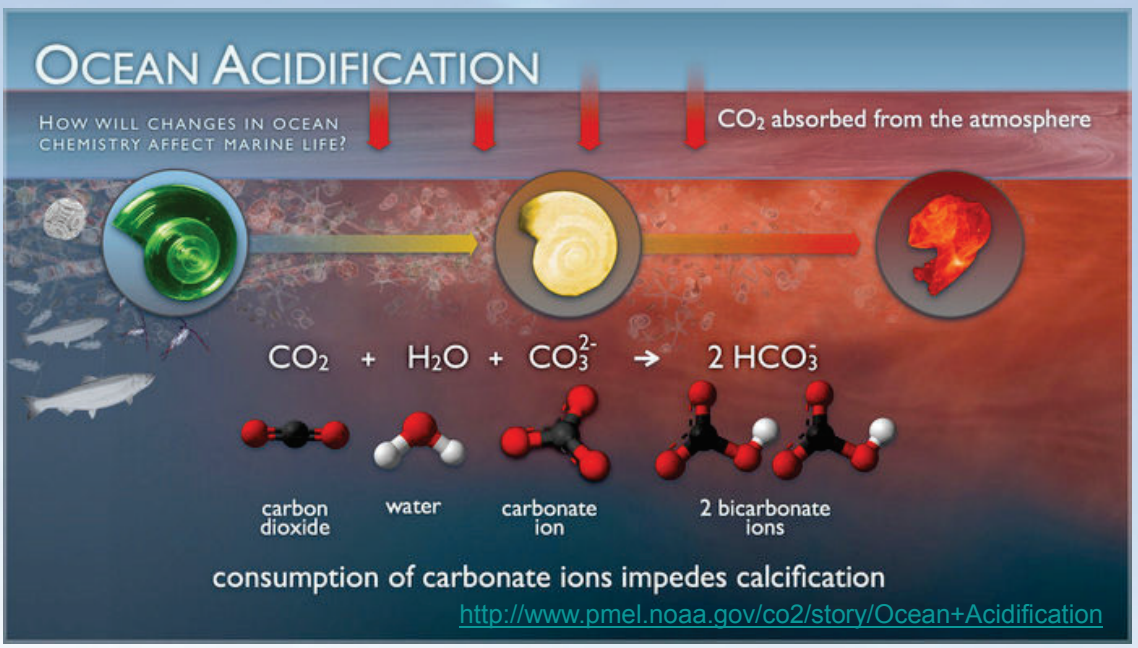
Fig 1.3: *Essentials of Meteorology*

Carbon Dioxide (CO_2)



Berner, *Science*, 276, 544, 1997

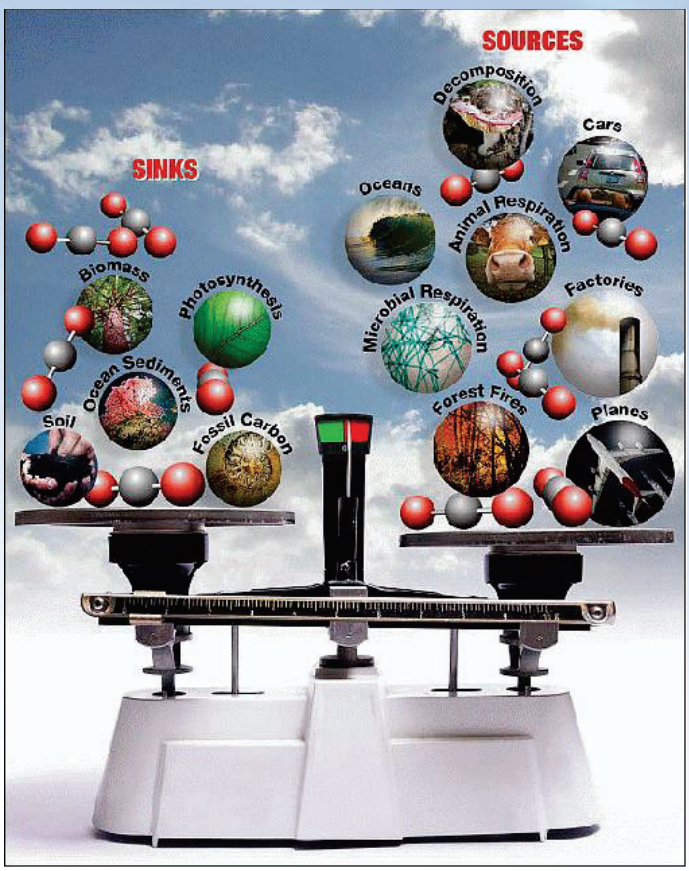
Recent Science



"There has been a 30% increase in the acidity of the ocean since 1700, and we now expect that by 2100, it will have become a 100% increase. This constitutes a rate of change in ocean chemistry that is 10 times anything scientists can document over the last 50 million years."

http://newswatch.nationalgeographic.com/2014/09/02/ocean-acidification-from-domestic-to-international/

Carbon Dioxide (CO_2) Cycle



Currently, there are more sources than sinks.

As a consequence, CO_2 in the air is rising.

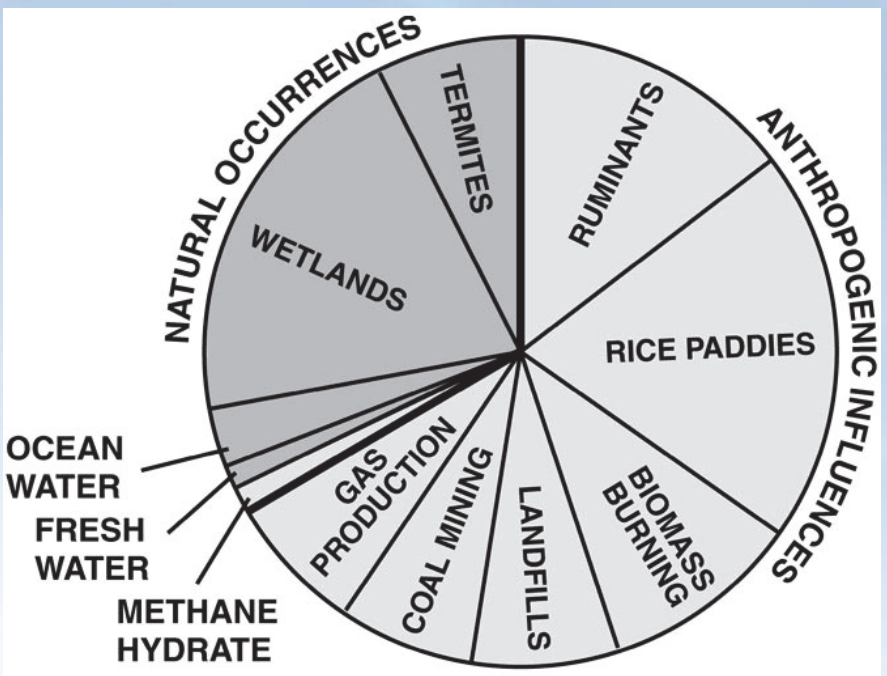
This rise is correlated with the rise in temperatures…

… but more on that in future lectures

Currently, few ways to reduce CO_2

https://directory.eoportal.org/web/eoportal/satellite-missions/o/oco-2

Methane Sources and Sinks



http://www.giss.nasa.gov/research/features/200409_methane/

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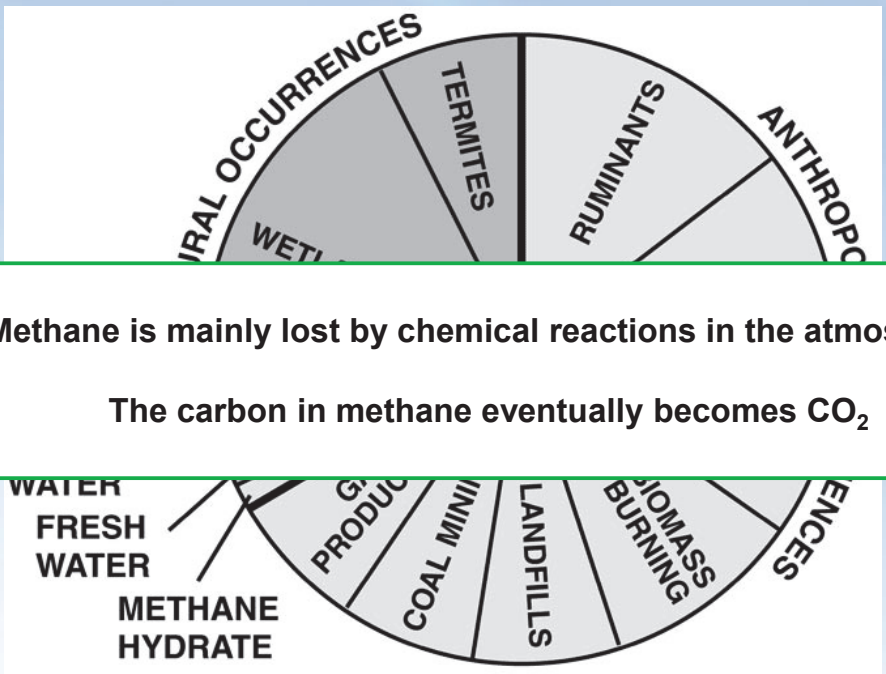
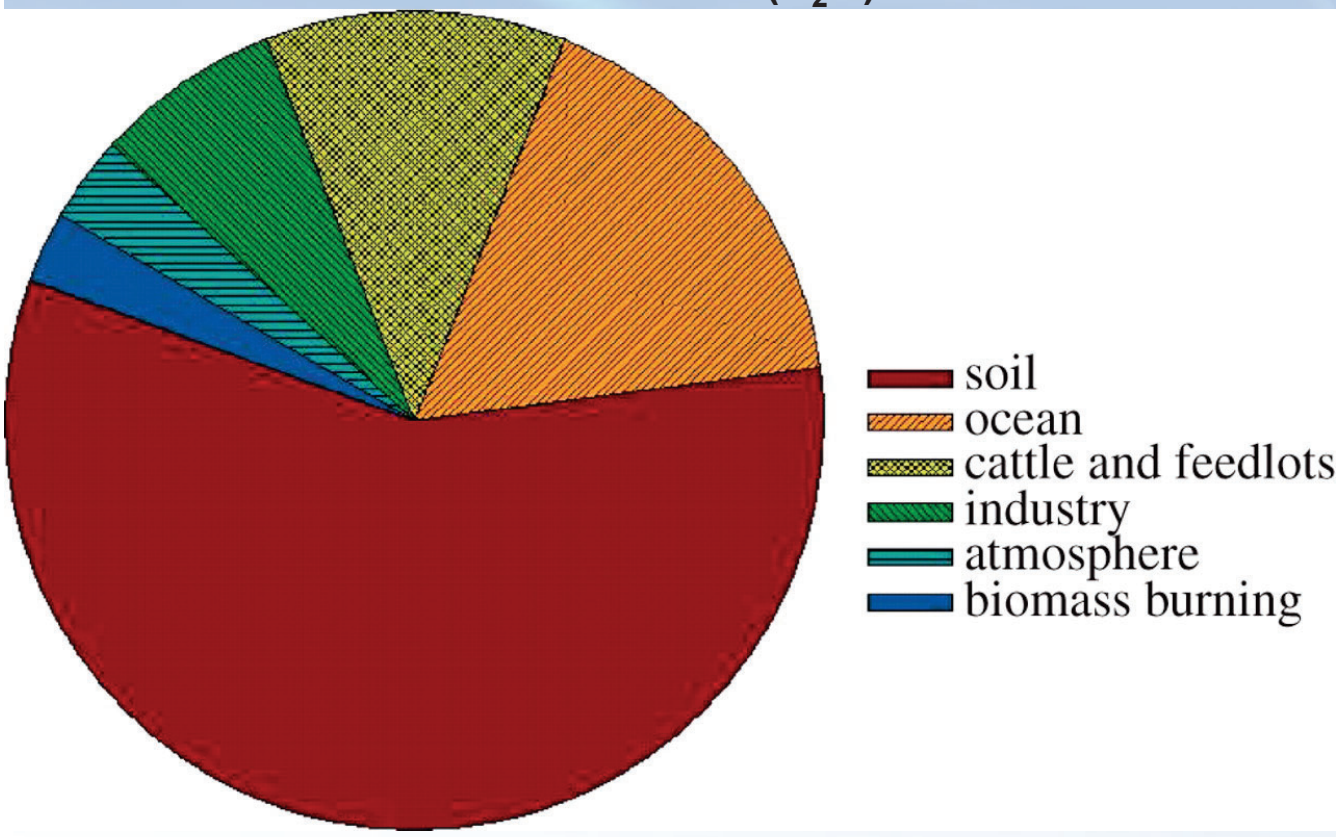


Methane is mainly lost by chemical reactions in the atmosphere

The carbon in methane eventually becomes CO_2

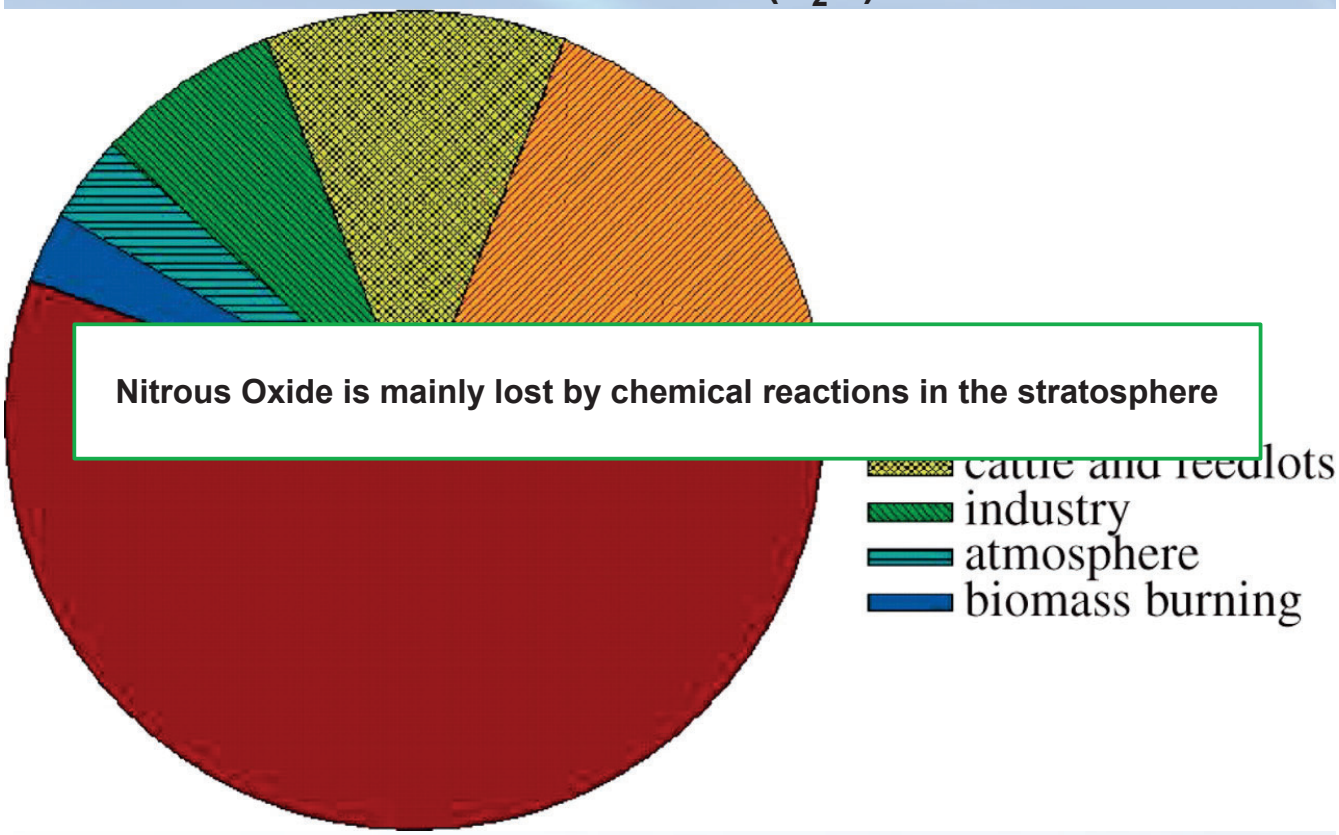
http://www.giss.nasa.gov/research/features/200409_methane/

Nitrous Oxide (N_2O)



http://rstb.royalsocietypublishing.org/content/367/1593/1157

Nitrous Oxide (N_2O)



Nitrous Oxide is mainly lost by chemical reactions in the stratosphere

http://rstb.royalsocietypublishing.org/content/367/1593/1157

Aerosols (really tiny!!!!)

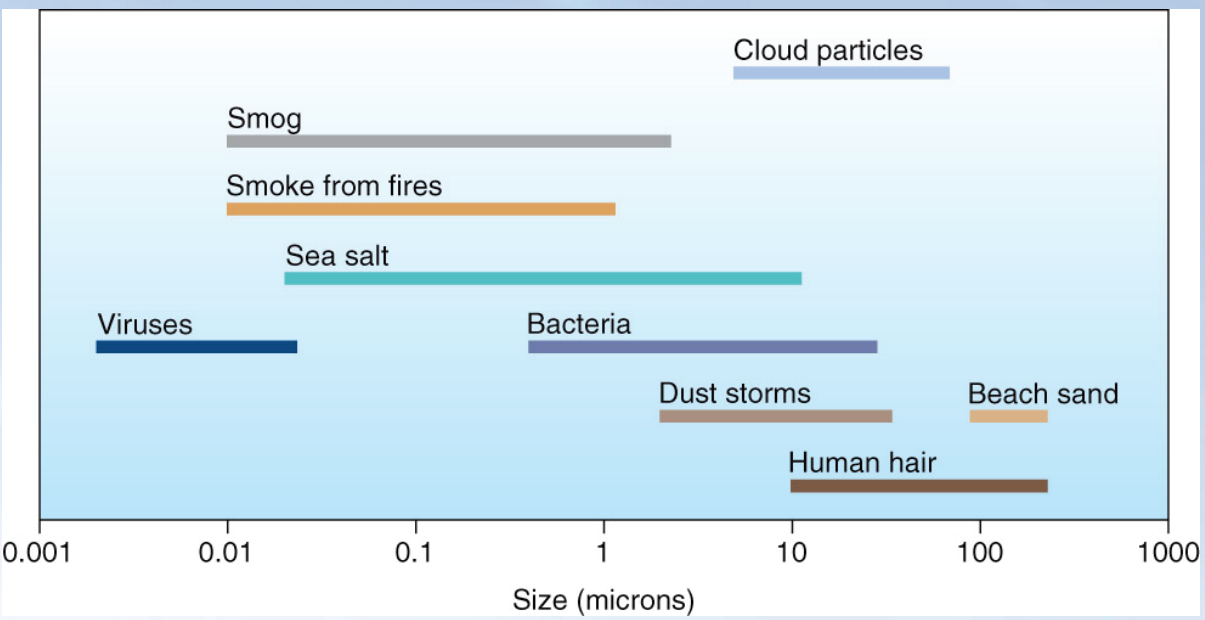
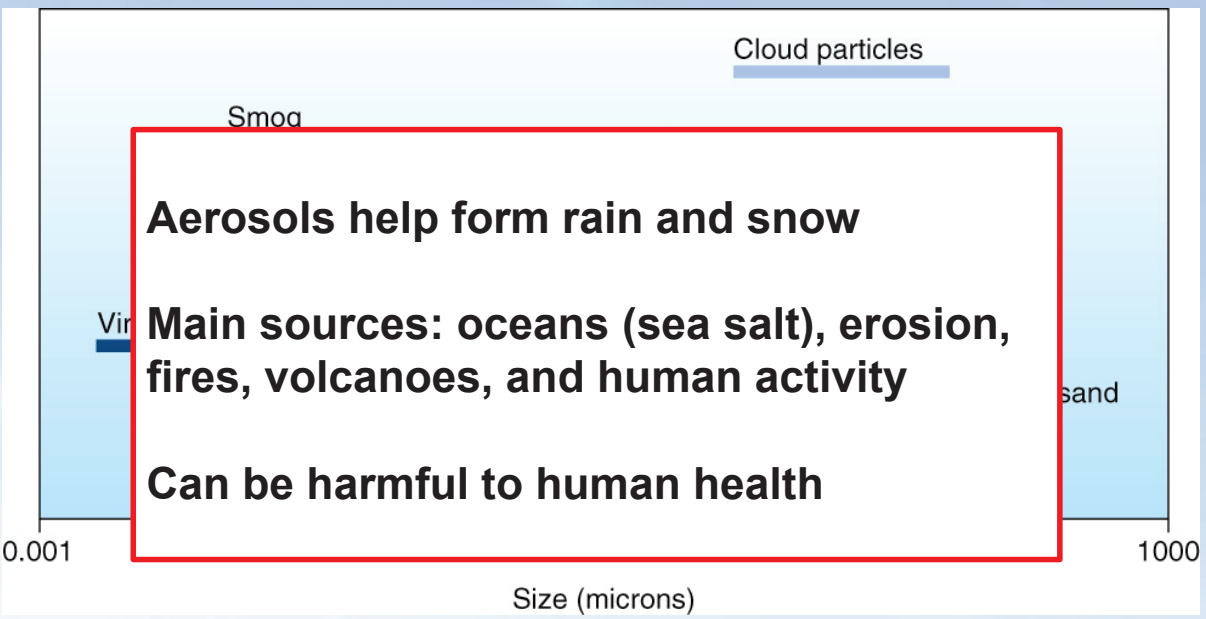


Fig 1-10 *Meteorology: Understanding the Atmosphere*

Aerosols (really tiny particles!!!!)



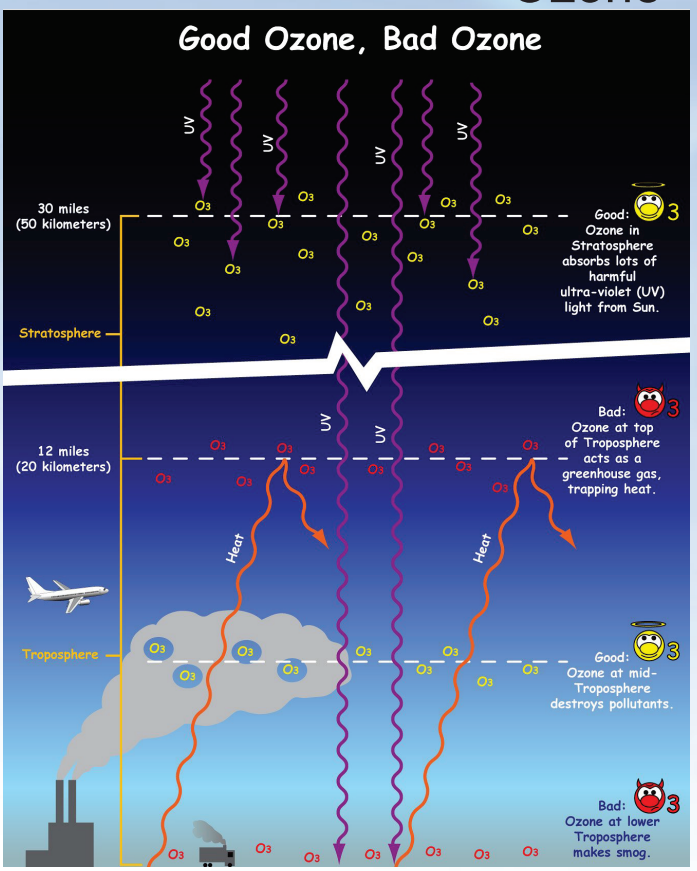
Aerosols help form rain and snow

Main sources: oceans (sea salt), erosion, fires, volcanoes, and human activity

Can be harmful to human health

Fig 1-10 *Meteorology: Understanding the Atmosphere*

Ozone



Absorbs UV radiation

Smog!!!

http://www.aoas.org/article.php?story=20080522125225466